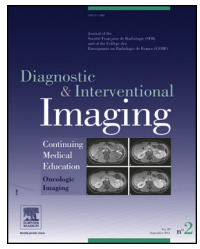
Diagnostic and Interventional Imaging (2015) **96**, 1293—1306



CONTINUING EDUCATION PROGRAM: FOCUS...

Tumors and pseudotumors of the hand: The role of imaging

M. Faruch Bilfeld*, F. Lapègue, C. Brun, S. Bakouche, M.-A. Bayol, H. Chiavassa-Gandois, N. Sans

Department of Radiology, Hôpital Pierre-Paul-Riquet, CHU Purpan, 1, place de Docteur-Baylac, 31059 Toulouse cedex 9, France

KEYWORDS
Bone tumor;
Wrist;
Hand;
MR imaging

Abstract The assessment of a swelling or mass of the wrist or the hand is commonly performed by radiologists. Because cysts on the wrist are, by far, the most frequent pathology. Diagnosis is usually based on standard radiography and ultrasound alone. Additional imaging techniques, and in particular MR imaging, are necessary to assess tumors, although malignant tumors of the hand are rare. Some benign cysts have pathognomonic characteristics visible on imaging. By understanding them, treatment planning may be improved.

A swelling in the hand is a frequent reason for radiological examinations. The role of the radiologist is to guide and prioritize the types of imaging techniques and to suggest a course of action, thereby helping the clinician to plan treatment.

The location explains the symptoms and the variety of etiologies [1] :

- the location is superficial: clinical signs appear early due to the deformity caused by the mass and are therefore directly visible upon examination. The superficial location makes the clinical examination easy and enables the radiologist to evaluate the lesion's aggressive behavior and how it may further evolve;
- anatomically, the location is very complex: a hand tumor or pseudotumor may originate from any anatomic structure, whether nervous, vascular, osseous, articular, muscle or joint [2]. The role of radiology, at the diagnosis stage, is first to clarify from which anatomical region the lesion is developing.

Etiologies are varied and therefore there is little literature available for an epidemiological analysis of the lesions [1,3].

* Corresponding author.
E-mail address: mariefaruch@hotmail.com (M. Faruch Bilfeld).

http://dx.doi.org/10.1016/j.diii.2015.09.011

The objective of this article was two-fold: First, we wished to clarify the contribution of various radiological techniques in assessing a swelling in the hand. Second, we wanted to suggest a diagnostic approach.

Imaging techniques

Standard radiography

Standard radiography enables the radiologist to answer the following three questions.

Did the lesion develop from osseous elements?

Standard radiography can help determine whether the lesion is a pseudotumor, such as a hypertrophic bone callus, an anatomic variant or a true tumor originating in the bone. Standard radiograph is essential to characterize an osseous tumor (Fig. 1). It helps identify the epiphysis, metaphysis or diaphysis location of the lesion, as well as whether the lesion is centered. It also detects signs of aggressive behavior, such as cortical rupture or periosteal appositions. And finally, by analyzing the tumor matrix standard radiography also provides information on the nature of the lesion [4].

Is there arthropathy?

Digital arthropathy, whether degenerative, inflammatory or microcrystalline, may cause pseudotumoral deformities in the fingers (Fig. 2). Radiography indicates the etiology based on whether one or several joints are affected, their location, and whether there is erosion or bone production.

Figure 1. Chondroma. Twenty-six-year-old man with swelling of the proximal phalanx of the middle finger on the right hand. (a) Radiograph shows well-circumscribed osteolytic lesion, centered, in the diaphysis, without periosteal appositions. (b) CT image in the sagittal plane shows no signs of aggressiveness and shows calcification centered in the lesion indicating a cartilaginous matrix (arrow). (c), (d) and (e) MR image in the coronal plane shows cartilaginous matrix hypo-intense on T1-weighted image (c), hyper-intense on T2-weighted image (d), with peripheral enhancement pattern of rings and arcs after IV administration of gadolinium chelate (e).

Figure 2. (a) Interphalangeal arthrosis. Radiograph shows homogeneous space narrowing with marginal osteophytosis and osteochondroma. (b) Psoriatic dactylitis: radiography. The whole finger is affected with marginal bone erosion (arrow), ''pencil and cup'' appearance, i.e. disappearance of the proximal phalangeal head with expanded distal phalanx (arrowhead) and bony ankylosis (star).

Are subcutaneous calcifications present?

Soft tissue calcifications may cause hand deformities (Fig. 3). They usually indicate a systemic disease, being calcium pyrophosphate crystal deposition, tophaceous gout, kidney failure, or connective tissue disease [5].

Figure 3. Soft tissue calcinosis: radiograph shows numerous calcifications of soft tissue in a case of scleroderma (CREST syndrome).

Ultrasonography

Owing to excellent spatial and temporal resolution, ultrasonography is the key technique to assess a mass of the hand [6].

Ultrasonography helps identify the anatomical structure from which lesions originate. For instance, using the elevator technique we may see that there is continuity between a neurogenic tumor and the nerve branches (Fig. 4). Ultrasonography helps detect if the vein is not compressed in case of thrombosis.

Ultrasonography is essential to analyze the tumor matrix, by identifying if the lesion is cystic (Fig. 5). A cyst appears as a well-circumscribed walled lesion, anechoic with posterior acoustic enhancement [7]. Color Doppler ultrasonography is essential to assess a tissue mass. The vascularity of a mass is a criterion of aggressiveness (Fig. 6) [8]. Finally, ultrasonography is also part of the treatment plan by guiding infiltration or biopsy procedures.

Computed tomography

Computed tomography (CT) is a second line investigation to assess swelling in the hand. CT is a key examination to characterize lesions originating in the bone. Its excellent spatial resolution provides an excellent cortical analysis (Fig. 7) and tumor matrix assessment (Fig. 1).

CT helps characterize deposits in soft tissues by measuring attenuation values (Fig. 8). While attenuation values of 160 to 170 HU indicate sodium urate crystals, they reach 450 HU for apatite and calcium pyrophosphate crystals [9].

MR imaging

MR imaging is a second line investigation for assessing masses in the hand. This examination is key to assess tumors. The sequences systematically used to characterize the tumor matrix include T1-weighted, T2-weighted, and gadolinium chelate enhanced sequences with fat suppression. MR imaging helps analyze the tumor matrix by identifying fatty, cartilaginous and cystic tissue in a given lesion (Figs. 1, 5, 9)

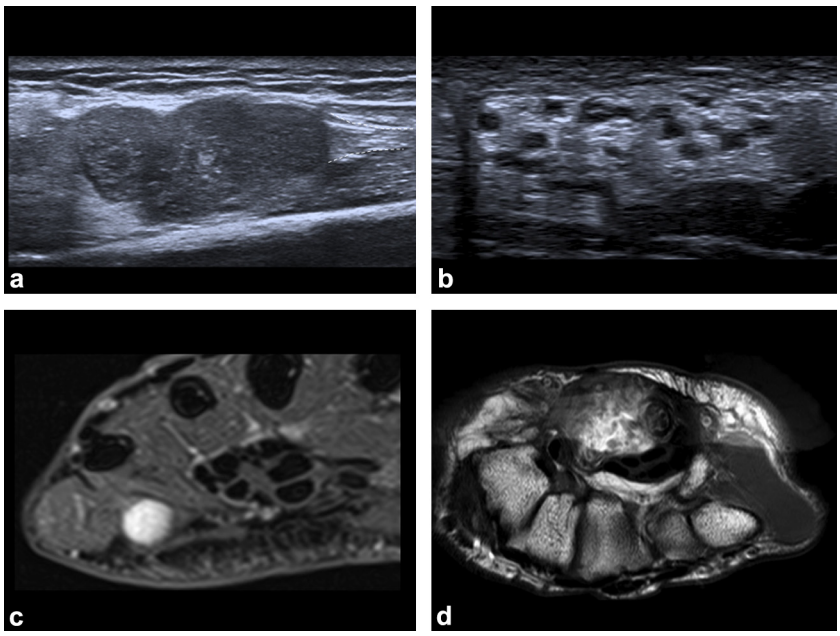


Figure 4. Nerve tumors. Intramuscular schwannoma (a) and (b). (a) Ultrasound in the longitudinal plane shows well-limited hypo-echoic lesion in continuity with a nerve (dots). (b) T1-weighted fat suppressed gadolinium chelate enhanced MR image shows well-limited enhancing lesion. Neural fibrolipoma of the median nerve (c) and (d). (c) Ultrasound in the axial plane demonstrates volume increase of nerve fascicles infiltrated by fat tissue. (d) T1-weighted MR image in the axial plan reveals hyper-intense mass indicating fat.

[8]. Gradient echo MR sequences show hemosiderin deposition that is characteristic for giant cell tumors of tendon sheath (Fig. 10) [10].

MR imaging shows features of aggressiveness, sign of malignancy: poorly defined margins, invasion into vascular-nervous or osseous structures, peritumoral edema, heterogeneous signal in case of necrosis and intense enhancement (Fig. 11) [8]. MR imaging helps discriminate between benign and malignant lesions with a sensitivity of 93% and a specificity of 82% [11].

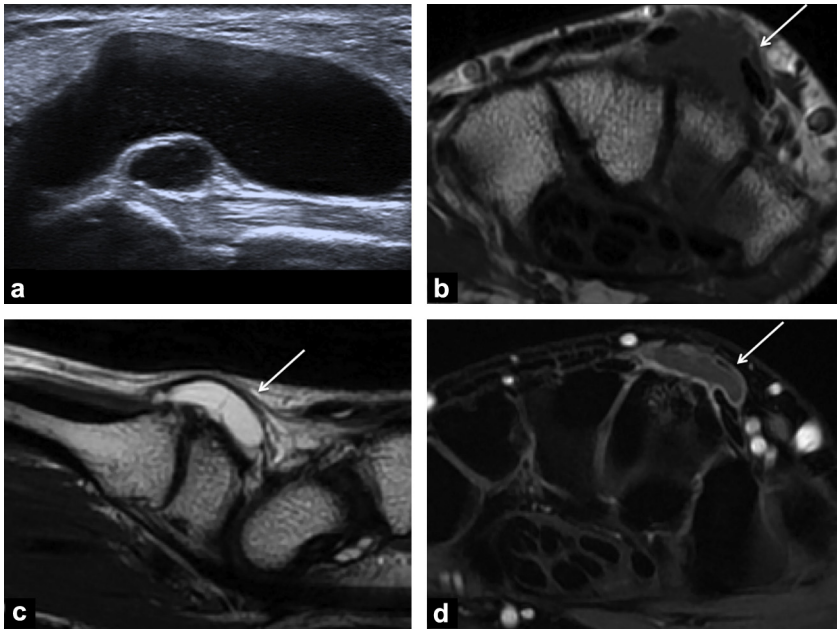


Figure 5. Characteristic mucoid cyst of the dorsal band of the carpus. (a) Ultrasound in the axial plane shows well-circumscribed, anechoic mass, with posterior acoustic enhancement. MR imaging in the sagittal plane shows hypo-intense mass on T1-weighted image (b), homogeneous hyper intensity on T-weighted image (c), enhancing periphery after IV administration of gadolinium chelate and saturation of the fat signal (d).

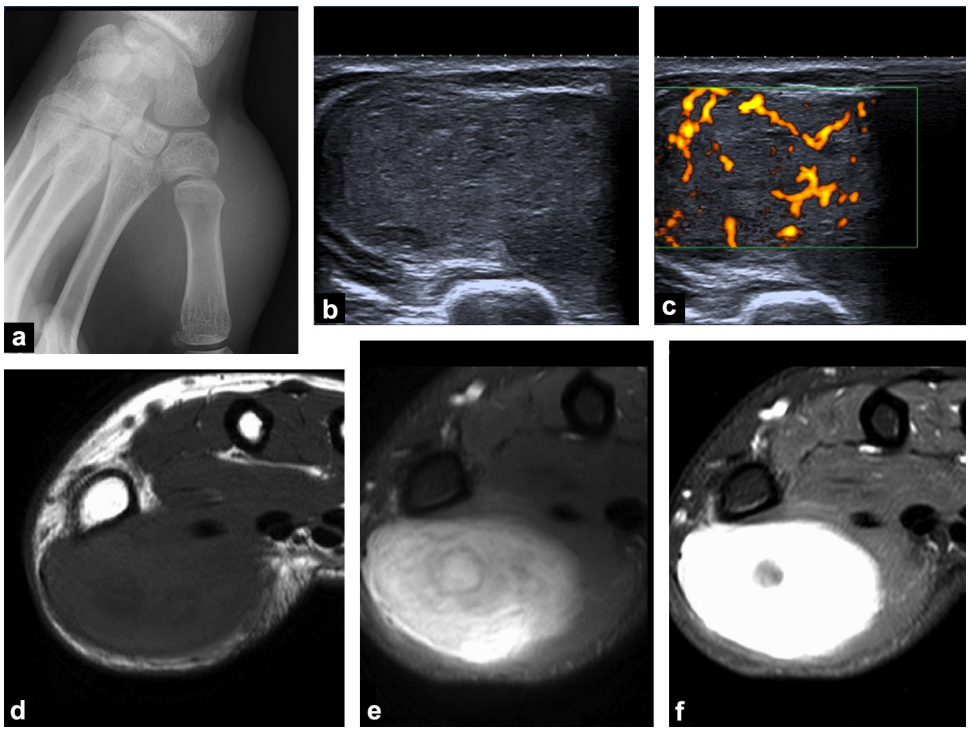


Figure 6. Synovial sarcoma. Fifteen-year-old girl with recent swelling. (a) Standard radiography: soft tissue mass without calcification and bone anomaly. (b) and (c) sonography: homogeneous well-circumscribed mass highly vascularized. T1-weighted MR image shows homogeneous well-circumscribed hypo-intense mass (d), which is hyper-intense on fat suppressed proton density (e), and enhances after IV administration of gadolinium chelate (f).

Diagnostic strategy

To assess masses of the hand or fingers, we suggest a three-step diagnostic strategy.

First step: ruling out a pseudotumor

Soft tissue pseudotumors are too numerous and varied to list here. Therefore, we will present an etiological analysis

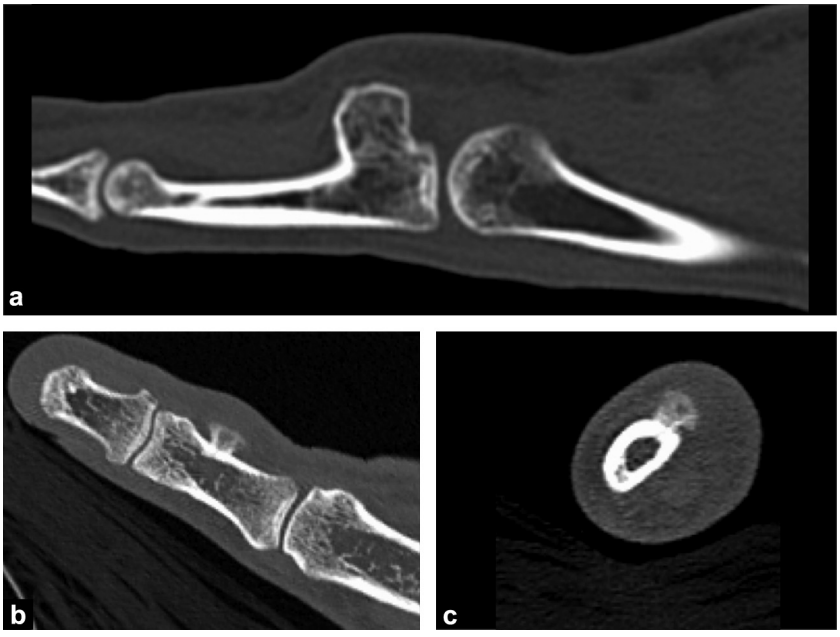


Figure 7. CT to characterize an osseous tumor. (a) Pedunculated exostose: CT scan sagittal reconstruction; continuity between cortical bone of exostose and cortical bone of phalanx. (b) and (c): Nora lesion: CT scan in the axial and frontal plane; periphery of ossified lesion attached to phalangeal periosteum.

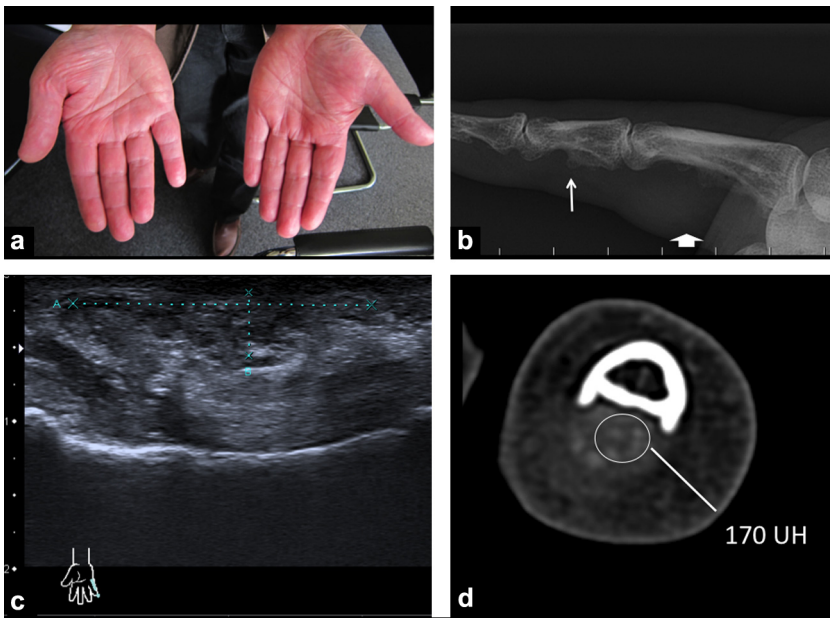


Figure 8. Swelling of proximal phalanx of the right 5th finger in a 55-year-old man. (a) Radiography shows non-specific thickening of soft tissues (arrow). Note the osteophytes (thin arrow). (B) Sonography shows hyper-echoic deposits close to the flexors. (C) CT shows deposits with an attenuation value of 170 HU, indicating deposits of sodium urate.

based on the anatomical part from which the lesions have developed. Ultrasonography, owing to an excellent spatial and temporal resolution, can often help identify the compartment from which the lesion developed.

Synovial pseudotumors

Doppler ultrasonography helps identify synovitis as a thickened, hypo-echoic and vascularized synovium [12]. Tenosynovitis, whether inflammatory, infectious or granulomatous, can cause deformities of the hand (Fig. 12).

Muscular pseudotumors

Muscular pseudotumors may be due to an anatomical variant such as an accessory muscle, for instance the extensor digitorum brevis manus on the dorsal band of the carpus [13]. They may also result from a reactive inflammatory process, as observed in proliferative myositis or circumscribed myositis ossificans [5,8].

Osseous pseudotumors

Accessory bones are frequently observed in the wrist and may be the cause of deformities. A carpal boss consists of an overgrowth in the dorsal aspect of the wrist at the base of the second and third carpometacarpal joints, which may cause a conflict with the extensor carpi [14]. The deformity is often due to a supernumerary bone, the os styloideum, but also to osteophytes or an exuberant osseous callus (Fig. 13).

Vascular pseudotumors

Ultrasonography, which combines real-time imaging, probe pressure and Doppler technique, makes it possible to easily diagnose venous and arterial thrombosis. A hypothenar hammer syndrome is a thrombosis or a pseudoaneurysm of the ulnar artery, secondary to repeat micro-trauma (Fig. 14) [15].

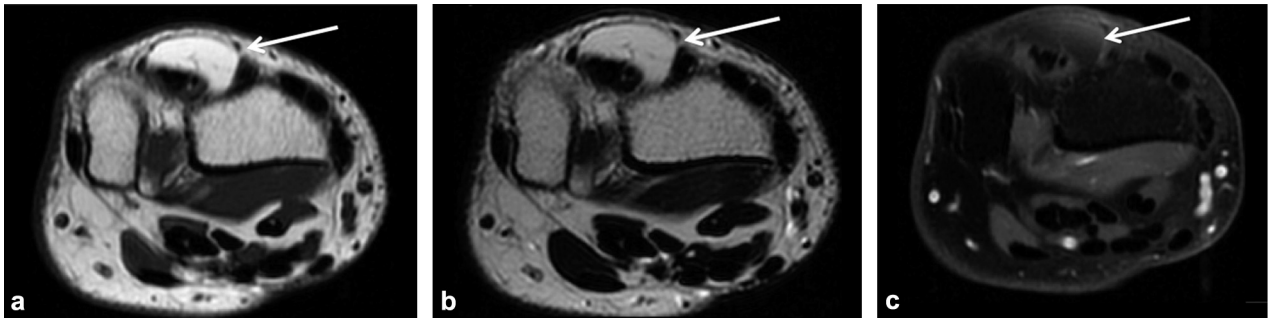


Figure 9. Lipoma on the dorsal band of the carpus. MR images in the axial plane show the fatty nature of the lesion, which is hyper-intense on T1-weighted images (a), hyper-intense on T2-weighted images (b) and hypo-intense on T1-weighted fat suppressed images obtained after IV administration of gadolinium chelate (c).

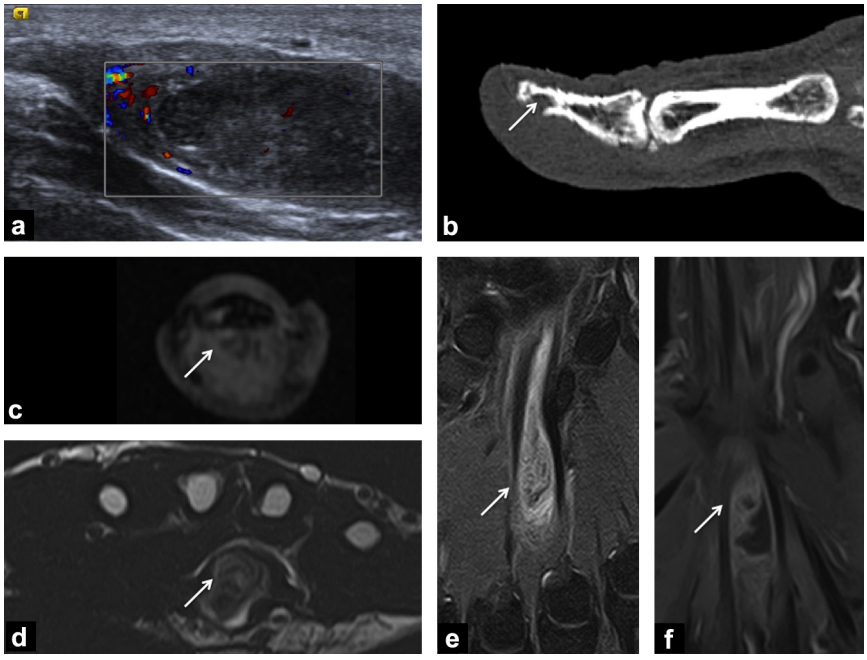


Figure 10. Giant cell tumors of tendon sheath. (a) Color Doppler sonography shows vascularized mass in the tendon sheath of the deep flexor. (b) CT in the sagittal plane shows erosion. (c), (d), (e) and (f) MRI: mass with deposits of hemosiderin without signal on gradient echo sequences (c), heterogeneous signal on T1-weighted image (d) and proton density fat suppressed image (f) and enhancement after IV administration of gadolinium chelate (e).

Subcutaneous pseudotumors

Dermal inclusion cysts are subcutaneous epidermal inclusions often caused by needle-stick injury (Fig. 15). Ultrasonography is useful to identify foreign bodies often not visible on standard radiographs [16]. Subcutaneous pseudotumors may be the sign of systemic disorders such as microcrystalline disorder (Fig. 8) or tumoral calcinosis (Fig. 3).

Second step: ruling out a cyst

Mucoid or ganglion cysts represent between 40 to 60% of all hand tumors [1,6]. The diagnosis is often based on the clinical examination that reveals a firm, painless and non-adherent swelling under the skin. Past trauma is sometimes associated [7]. The cysts arise from a myxoid degeneration

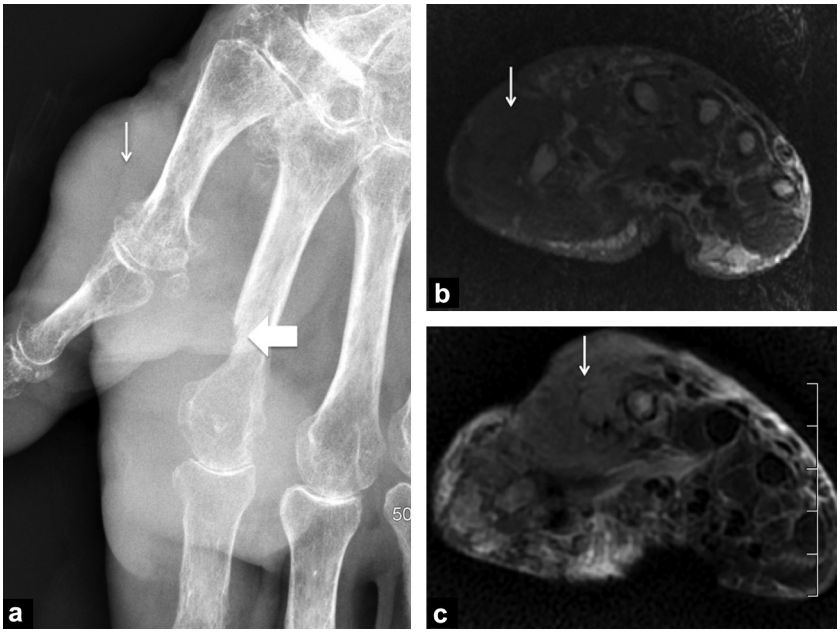


Figure 11. Epithelioid sarcoma. Seventy-seven-year-old woman with a mass in the thenar eminence. Imaging shows signs of aggressiveness indicating malignancy. (a). Radiography shows soft tissue swelling (arrow) in the thenar eminence with osteolysis at the second metacarpal (bold arrow). T1-weighted MR image shows hypo-intense mass (b) enhancing after IV administration of gadolinium chelate (c), infiltrating the tendon and vascular and nervous structures.

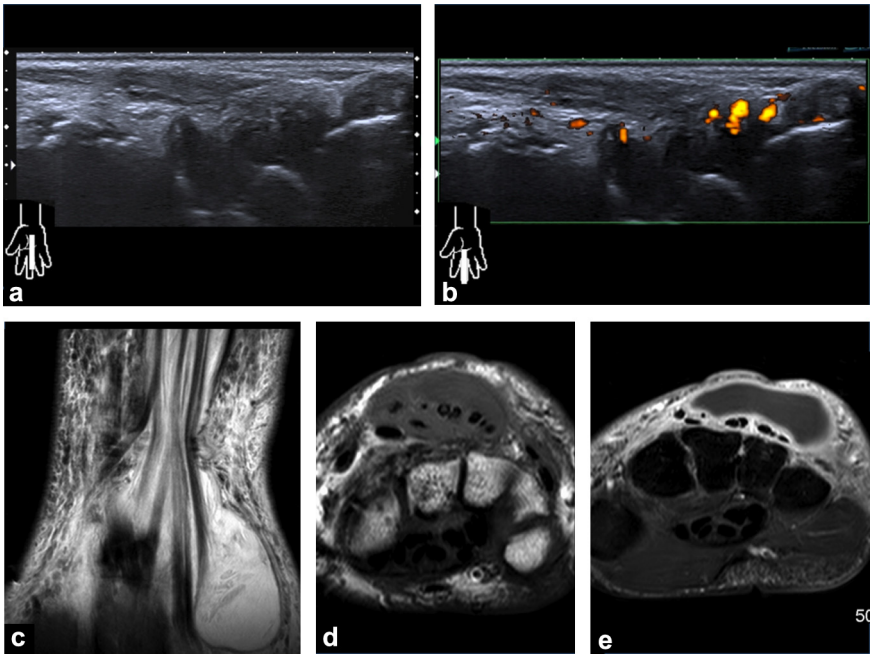


Figure 12. Synovial pseudotumors. (a) and (b) Synovitis of metacarpo-phalangeal joint in a 45-year-old woman followed up for rheumatoid arthritis. Sonography sagittal plane of the dorsal band of the carpus: hypo-echoic thickening of the synovium (a) Doppler view (b). (c), (d) and (e): Tenosynovitis after injury to the middle finger in a 32-year-old farmer. T2-weighted MR image in the coronal plane shows effusion in the flexor sheath (c), T1-weighted image (d) and fat suppressed T1-weighted image after IV administration of gadolinium chelate (e).

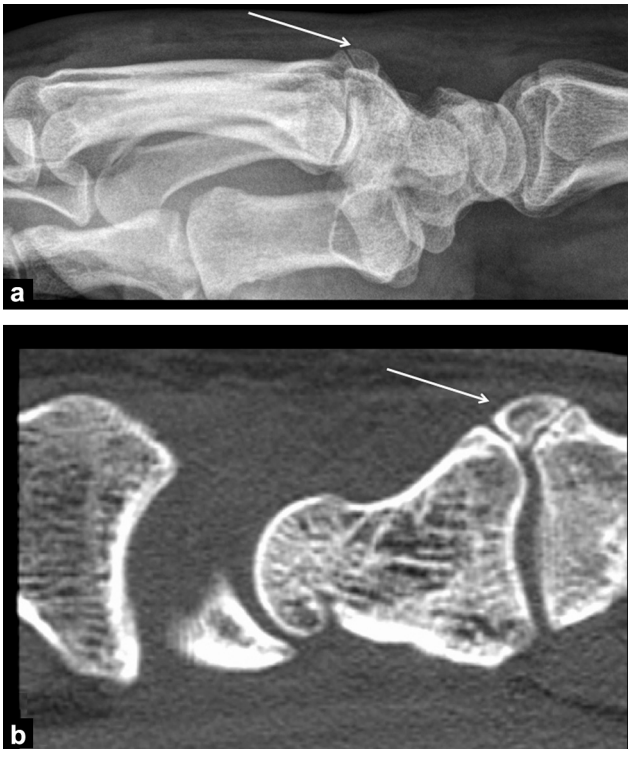


Figure 13. Osseous pseudotumor: carpal boss due to os styloideum. (a) Standard radiography and (b) CT in sagittal reconstruction show the os styloideum (arrow).

of the connective tissue at, and around, the joint capsule, and contain an abnormal amount of fluid. In 95% of the cases, cysts have a characteristic appearance and ultrasonography is sufficient to establish a diagnosis [7]. Ultrasonography shows a well-circumscribed lesion with anechoic liquid and posterior acoustic enhancement (Fig. 5) [6]. MR imaging is useful to assess atypical forms—pseudotumors, hemorrhagic, ruptured or thick-walled cysts (Fig. 16) [17]. In 70% of the cases, the cysts are located on the dorsal band of the carpus, in front of the scapholunate ligament [7]. It is necessary to identify the correct site of origin of cysts to treat them surgically. MR imaging is generally useful as it demonstrates the articular communication before the surgery.

Third step: characterize a tumor mass

Non-cystic hand tumors are often encountered in clinical practice. In a series of 134 hand and wrist masses analyzed by Capelastegui et al., non-cystic tumors represented 25% of all masses that included 0.2% of malignant tumors [1]. In this paper we will not present a list of all the hand and wrist tumors; we will only discuss the most frequently observed.

Giant cell tumors of tendon sheath

These tumors correspond to a localized form of pigmented villonodular synovitis. It is the second most common soft tissue mass of the hand after mucoid cysts [3]. They occur between the age of 30 and 50 years, mostly in women [18]. The clinical signs are a painless swelling, firm and mobile under the skin [8]. Ultrasonography shows a homogeneous, hypo-echoic, well-defined mass, close to a tendon (Fig. 10). MR imaging shows the solid portion of the lesion, which

enhances after IV administration of gadolinium chelate and shows small areas of low signal on T2-weighted MR images, better visible on gradient echo sequences [10]. Cortical bone erosion may be observed adjacent to the tumor. These lesions may be treated by surgical excision. Recurrence is frequent, mainly associated with incomplete excision [19].

Glomus tumor

Glomus tumor is a benign tumor that originates in the glomus, which is an arterio-venous shunt involved in body temperature regulation. Clinically, glomus tumor is typically locally painful, causing paroxysmal pain in response to pressure and cold. Pain is relieved following application of a tourniquet around the arm [15]. Ultrasonography is useful to detect these small tumors (2 mm on average) beneath the nail. On MR imaging glomus tumor is isointense on T1- and hyper-intense on T2-weighted images, with homogenous enhancement after IV administration of gadolinium chelate [20]. MR angiography shows tumor blush beneath the nail (Fig. 17). Glomus tumor can be surgically removed.

Fibromatosis of the palmar fascia or Dupuytren's contracture

This condition corresponds to a fibrotic contracture of the palmar and digital fascia. The incidence is 1 to 2% in the general population [21]. The etiology is unknown, but is probably multifactorial. This condition is often associated with diabetes. Patients present one or several subcutaneous nodules that progress to indurated cords leading to flexion contractures. Diagnosis is based on the clinical signs. Imaging is usually performed to plan treatment. Ultrasonography shows nodules as hypo-echoic thickening of the palmar aponeurosis (Fig. 18) [22]. MR imaging shows cords with intermediate signal intensity from palmar aponeuroses to subcutaneous tissues parallel to the flexor tendons [8]. Treatment is surgical excision or percutaneous needle fasciotomy.

Nerve tumors

Schwannomas and neurofibromas are the most frequent malignant peripheral nerve tumors [23]. Schwannomas, a proliferation of Schwann cells, are encapsulated tumors. They arise eccentrically from the nerves. Neurofibromas are non-encapsulated tumors, and consist of Schwann cells, fibroblasts and perineurial cells. Multiple neurofibromas occur in type 1 neurofibromatosis. In this case, degeneration is possible.

The most frequent clinical signs are slowly growing masses in the soft tissues, usually painless [8]. In large lesions, imaging can identify its location in relation to the nerve. Ultrasonography shows fusiform hypo-echoic lesions along the nerve. Ultrasonography is key to assess these lesions by identifying an entering and exiting nerve (Fig. 4). On MR imaging the lesions are well-circumscribed, hypo-intense on T1- and hyper-intense on T2-weighted images, and shows enhancement after IV administration of a gadolinium chelate (Fig. 4). The center of the lesion consists of nerve fibers and tumor cells and is hypo-intense on T2-weighted images and shows enhancement after IV administration of a gadolinium chelate, unlike the myxoid

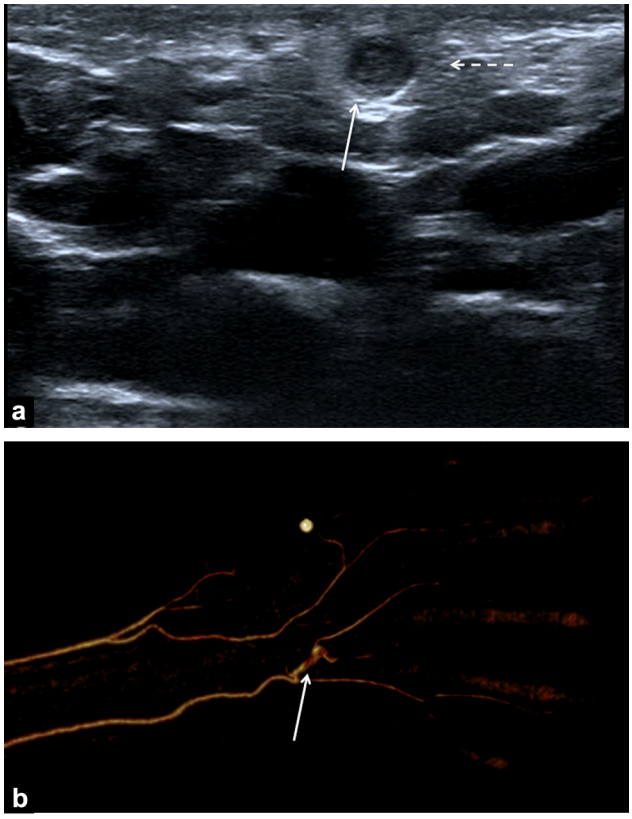


Figure 14. Vascular pseudotumor: hypothenar hammer syndrome. Twenty-two-year-old man with a past trauma in the wrist presents a swelling of the hypothenar eminence and paresthesia on the palmar aspect of the 4th and 5th fingers. (a) Ultrasound shows pseudoaneurysm of a branch of the ulnar artery (arrow) in contact with a branch of the ulnar nerve (dotted arrow) (b) CT angiography using VRT (volume rendering technique) shows a pseudoaneurysm of a branch of the ulnar artery (arrow).

periphery of the lesion, which is hyper-intense on T2-weighted images. This combination results in the so-called ''target sign'', more frequently observed in neurofibromas than in schwannomas.

Post-traumatic neuromas are hyperplastic scars reactive to nerve injury. Electric-shock-like neuropathic pain is a suggestive clinical symptom. Ultrasonography is considered the modality of choice for the diagnosis. An excellent spatial resolution makes it possible to detect small lesions, a nodular appearance or a disparity in the caliber of a nerve painful on ultrasound palpation [24].

Eighty percent of neural fibrolipomas are found on the median nerve [25]. Epineurium and perineurium are infiltrated by mature fat cells that dissociate the nerve fascicles. Imaging features are characteristic, making biopsies unnecessary for a definite diagnosis [26]. On MR imaging and ultrasonography, nerve fascicles appear thickened, surrounded or infiltrated by fat (Fig. 4).

Vascular tumors

Benign vascular tumors form a heterogeneous group of vascular tumors or hemangiomas and vascular malformations [27]. Venous malformations are the most frequent vascular tumors of the limbs [15]. They may be asymptomatic or

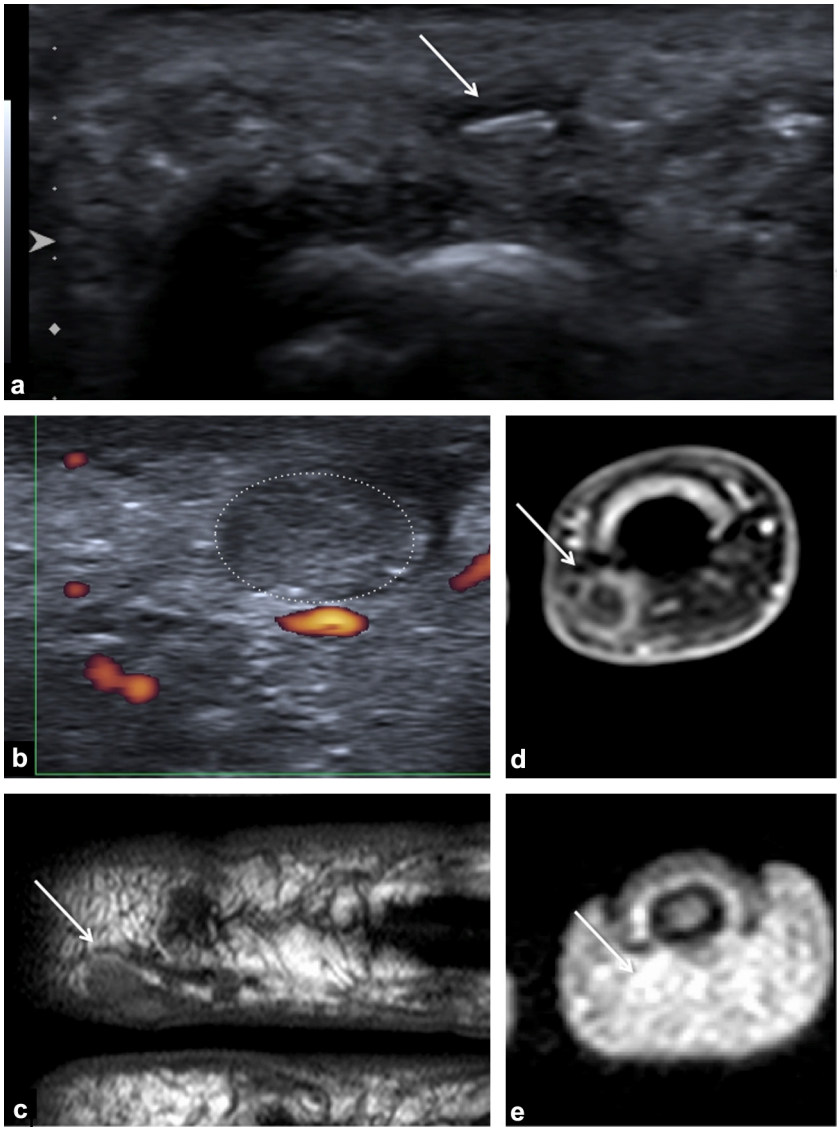


Figure 15. Subcutaneous pseudotumor. (a) Foreign body: splinter visible on sonography as a hyper-echoic line without posterior shadowing, with subcutaneous fat infiltration. (b), (c), (d) and (e) dermal inclusion cysts: sonography shows a hyper-echoic slightly stippled nodule on the lateral part of the nail (b) and, hypo-intense on T1-weighted image (c), hyper-intense on proton density (e), with peripheral enhancement after IV administration of gadolinium chelate (d).

present fluctuating masses, sometimes painful, exacerbated with exercise. Radiograph shows phleboliths, small rounded calcifications (Fig. 19). Ultrasonography reveals a cluster of serpentine, dilated veins compressed when pressed over with the ultrasound probe. On MR imaging vascular malformations present as well- or ill-defined infiltrating masses, involving several anatomic structures. The lesion shows hypersignal on T1-weighted and STIR sequences. Contrast-enhanced MR imaging shows tubular structures indicating vascular origin (Fig. 19).

Intramuscular hemangiomas are benign vascular tumors. They occur in young adults and consist of vascular and adipose tissue [15]. Pulsed Doppler ultrasonography confirms rapid flow within tissue mass. MR imaging shows a poorly circumscribed lesion that is hyper-intense on T1- and T2-weighted images with marked enhancement after IV administration of gadolinium chelate.

Chondromas

Chondromas of the hand represent 35 to 65% of all chondromas [28]. The lesion is located in the metaphysis and diaphysis with possible extension to the entire diaphysis. Chondromas are often incidentally discovered after fracture.

Generally, a distinguishing feature of chondromas of the fingers is the absence of calcification (Fig. 1). When the lesion is large, bones are thickened, causing an ''enlarged finger'' MR imaging shows a cartilaginous matrix that is hypo-intense on T1-, and hyper-intense on T2-weighted images. Contrast-enhanced MR images show arcs and rings [4]. In

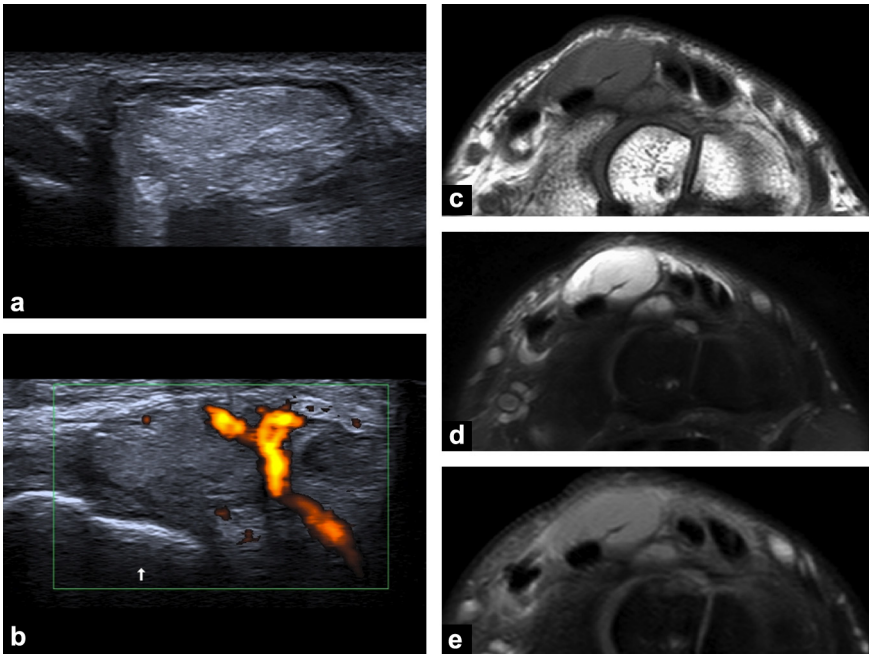


Figure 16. Pseudotumoral hemorrhagic cyst (a) and (b). Sonographic image shows well-circumscribed heterogeneous mass with hyper-echoic contents (a), with Doppler coded margins (b). (c), (d) and (e) T1-weighted MR image in the axial plane shows internal hemorrhagic changes (c) T2-weighted MR image in the axial plane shows (d) hyper signal, without enhancement after IV administration of gadolinium chelate (e).

rare cases, they become malignant in isolated finger location without enchondromatosis context.

Malignant tumors

Malignant tumors represent less than 1% of hand swellings [1,3]. The most commonly observed malignant tumors are sarcomas, with synovial sarcomas and epitheloid sarcoma being the most frequently observed histological types [29]. Imaging may reveal signs of aggressiveness indicating malignancy (Fig. 6) [8]. Sometimes, there are no signs of tumor aggressiveness. Some sarcomas present as well-defined

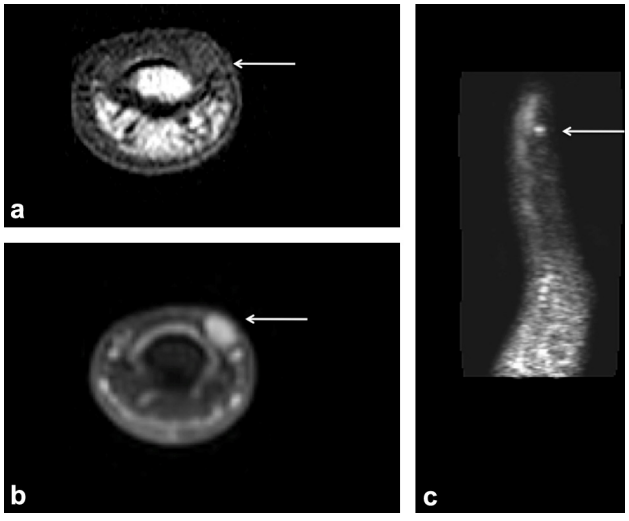


Figure 17. Glomus tumor. T1-weighted MR image in the axial plane shows hypo-intense mass of 2-mm diameter on the lateral part of the nail (a), after IV administration of gadolinium chelate (b). MR angiography (c) shows the tumor blush.

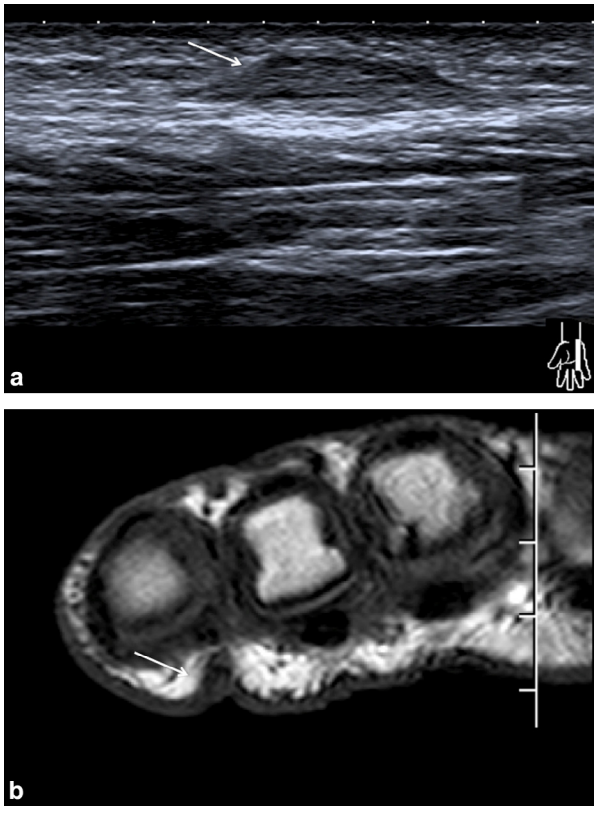


Figure 18. Superficial fibromatosis of the palmar fascia. (a) Sonographic image in the sagittal plane shows hypo-echoic nodule causing a fusiform thickening of the palmar aponeurosis. (b) T1-weighted MR image in the axial plane shows hypo-intense nodule arising from the superficial palmar aponeurosis, causing skin retraction.

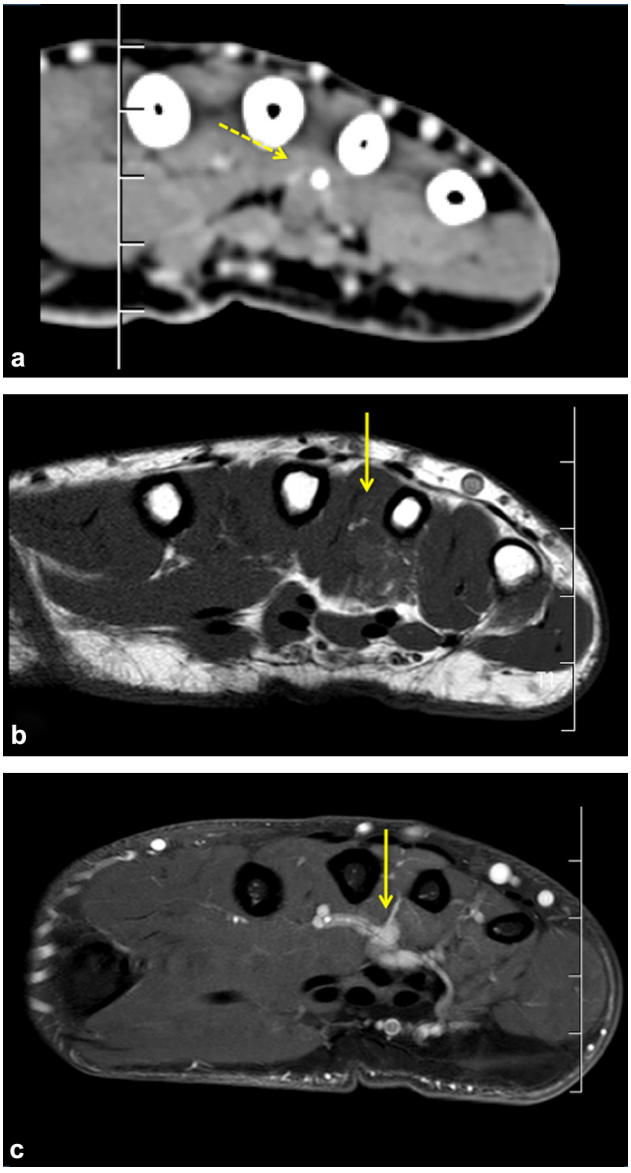


Figure 19. Venous malformation. (a) CT shows hypo-attenuating mass in the third intermetacarpal space with phlebolith (dotted arrow). (b) and (c) T1-weighted MR image in the axial plane shows hypo-intense mass (b), with typical serpentine enhancement (c).

masses without involvement of soft tissue or peritumoral edema (Fig. 6). Therefore, tumors without characteristic features like the benign tumors described above must be carefully assessed. The clinical and radiological presentations of these tumors must be discussed in multidisciplinary meetings to plan their treatment. An ultrasonography-guided or surgical biopsy may be considered.

TAKE-HOME MESSAGES

- Standard radiography and ultrasonography are usually sufficient to assess hand and wrist swelling.
- In case of a pseudotumor, standard radiography and ultrasonography can determine the nature of the lesion by analyzing the region where it has originated.
- Mucoid cysts represent 40 to 60% of swellings in the hand and wrist. In most cases, ultrasonography is sufficient to diagnose them and decide on treatment.
- Tumors of hands and wrists are various. Most are benign.
- MRI is required for tumor characterization.
- Benign tumors are the most frequently observed tumors and have clinical and radiological features making diagnosis possible.
- Any lesion of indeterminate nature must be discussed in a multidisciplinary meeting to plan diagnosis and treatment.

Clinical case

A 65-year-old man presented with a painless mass in the hypothenar eminence that appeared one year ago (Fig. 20).

X-rays showed normal findings (Fig. 21), ultrasonographic examination was thus performed.

Questions

1. Describe the ultrasonographic findings.
2. Do you ask for further examination(s)? If yes, which one(s) and why?
3. MR imaging was performed (Fig. 22): describe the imaging findings on the three sequences.
4. What is the most appropriate therapeutic option?

Responses

1. Doppler ultrasonography shows a well-circumscribed, non-cystic mass, not compressed when pressed over with the ultrasound probe, slightly stippled, hyper-echoic and not color-coded.

Figure 20. Swelling of the thenar eminence.

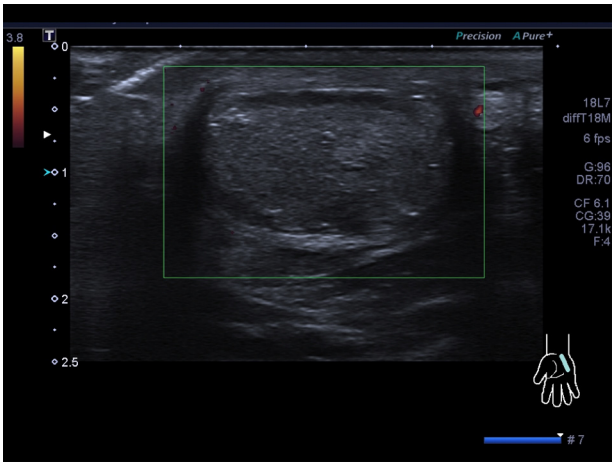


Figure 21. Sonographic image in the axial plane.

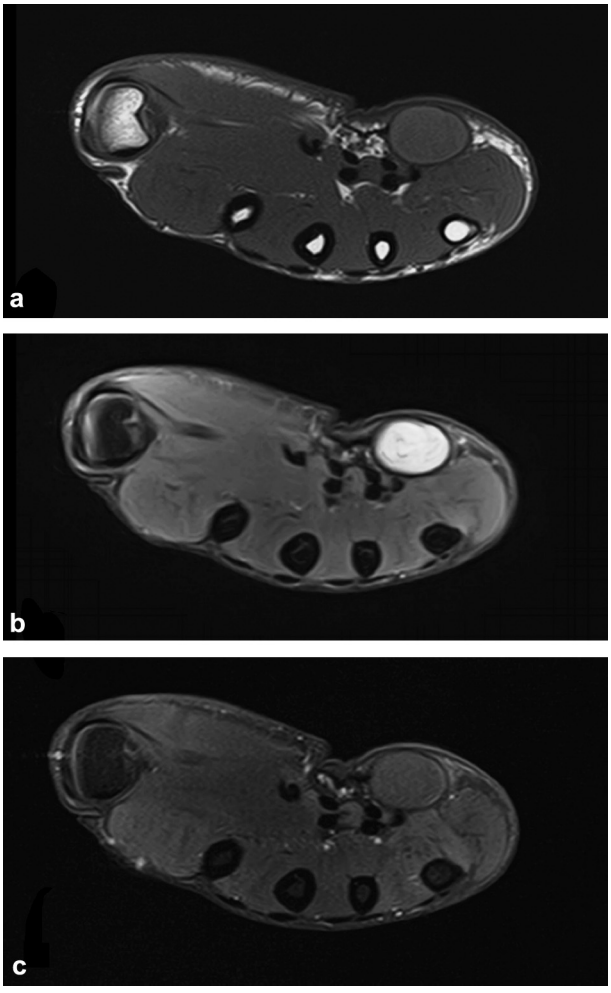


Figure 22. MR imaging. (a) T1-weighted image in the axial plane. (b) Proton density weighted image in the axial plane. (c) Fat suppressed T1-weighted image in the axial plane after IV administration of gadolinium chelate.

2. A mass in soft tissues is assessed with MR imaging.
3. MR imaging confirms that the mass is well-circumscribed, hyper-intense on T1-weighted image, hyper-intense on T2-weighted images, with no enhancement after IV administration of gadolinium chelate. Soft tissues adjacent to tumor show no abnormalities and no aggressiveness features.
4. Faced with an undetermined mass, a multidisciplinary meeting is required. A percutaneous biopsy is recommended.

The results of histopathological analysis indicated an epidermoid cyst.

It is a pseudotumor secondary to post-trauma introduction of epithelial tissue in the dermis. The histological findings showed a keratinized squamous epithelium, with cells desquamating into the cyst cavity and forming a whitish substance. Ultrasonography showed a well-circumscribed mass with heterogeneous hyper-intense contents. MR imaging showed a cyst with hyper-intense contents on T1- and T2-weighted images due to keratin. The pseudotumor was treated by curettage.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] Capelastegui A, Astigarraga E, Fernandez-Canton G, Saralegui I, Larena JA, Merino A. Masses and pseudomasses of the hand and wrist: MR findings in 134 cases. Skeletal Radiol 1999;28(9):498—507.
[2] Garcia J, Bianchi S. Diagnostic imaging of tumors of the hand and wrist. Eur Radiol 2001;11(8):1470—82.
[3] Sookur PA, Saifuddin A. Indeterminate soft tissue tumors of the hand and wrist: a review based on a clinical series of 39 cases. Skeletal Radiol 2011;40(8):977—89.
[4] Sans N, Perroncel G. Imagerie des tumeurs osseuses. Montpellier: Sauramps Medical; 2014. p. 13—33 [67—89].
[5] Touraine S, Wybier M, Sibileau E, Genah I, Petrover D, Parlier-Cuau C, et al. Non-traumatic calcifications/ossifications of the bone surface and soft tissues of the wrist, hand and fingers: a diagnostic approach. Diagn Interv Imaging 2014;95(11):1035—44.
[6] Bianchi S, Della Santa D, Glauser T, Beaulieu J-Y, van Aaken J. Sonography of masses of the wrist and hand. AJR Am J Roentgenol 2008;191(6):1767—75.
[7] Freire V, Guérini H, Campagna R, Moutounet L, Dumontier C, Feydy A, et al. Imaging of hand and wrist cysts: a clinical approach. AJR Am J Roentgenol 2012;199(5):W618—28.
[8] Railhac JJ, Ponsot A. Imagerie des tumeurs des tissus mous. Montpellier: Sauramps Medical; 2010. p. 14—52 [327—34].
[9] Gerster JC, Landry M, Dufresne L, Meuwly JY. Imaging of tophaceous gout: computed tomography provides specific images compared with magnetic resonance imaging and ultrasonography. Ann Rheum Dis 2002;61(1):52—4.
[10] Murphey MD, Rhee JH, Lewis RB, Fanburg-Smith JC, Flemming DJ, Walker EA. Pigmented villonodular synovitis: radiologic-pathologic correlation. Radiographics 2008;28(5):1493—518.
[11] Gielen JLMA, De Schepper AM, Vanhoenacker F, Parizel PM, Wang XL, Sciot R, et al. Accuracy of MRI in characterization of

soft tissue tumors and tumor-like lesions. A prospective study in 548 patients. Eur Radiol 2004;14(12):2320—30.
[12] Cyteval C. Doppler ultrasonography and dynamic magnetic resonance imaging for assessment of synovitis in the hand and wrist of patients with rheumatoid arthritis. Semin Musculoskelet Radiol 2009;13(1):66—73.
[13] Capo JT, Shamian B, Li Y. Extensor digitorum brevis manus muscle in association with a metacarpal boss. J Plast Surg Hand Surg 2014;48(2):152—4.
[14] Boggess B, Berkoff D. Dorsal wrist mass: the carpal boss. BMJ Case Rep 2011;23.
[15] Drapé JL, Feydy A, Guerini H, Desmarais E, Godefroy D, Le Viet D, et al. Vascular lesions of the hand. Eur J Radiol 2005;56(3):331—43.
[16] Horton LK, Jacobson JA, Powell A, Fessell DP, Hayes CW. Sonography and radiography of soft-tissue foreign bodies. AJR Am J Roentgenol 2001;176(5):1155—9.
[17] Drapé JL, Idy-Peretti I, Goettmann S, Salon A, Abimelec P, Guérin-Surville H, et al. MR imaging of digital mucoid cysts. Radiology 1996;200(2):531—6.
[18] Kransdorf MJ. Benign soft-tissue tumors in a large referral population: distribution of specific diagnoses by age, sex, and location. AJR Am J Roentgenol 1995;164(2):395—402.
[19] Lanzinger WD, Bindra R. Giant cell tumor of the tendon sheath. J Hand Surg Am 2013;38(1):154—7.
[20] Drapé JL, Idy-Peretti I, Goettmann S, Wolfram-Gabel R, Dion E, Grossin M, et al. Subungual glomus tumors: evaluation with MR imaging. Radiology 1995;195(2):507—15.
[21] Yacoe ME, Bergman AG, Ladd AL, Hellman BH. Dupuytren's contracture: MR imaging findings and correlation between MR signal intensity and cellularity of lesions. AJR Am J Roentgenol 1993;160(4):813—7.
[22] Créteur V, Madani A, Gosset N. Ultrasound imaging of Dupuytren's contracture. J Radiol 2010;91(6):687—91.
[23] Lin J, Martel W. Cross-sectional imaging of peripheral nerve sheath tumors: characteristic signs on CT MR imaging, and sonography. AJR Am J Roentgenol 2001;176(1):75—82.
[24] Chen K-H, Lee K-F, Hsu H-C, Huang W-C, Hsiao K-Y, Fang K-M. The role of high-resolution ultrasound in the diagnosis of a traumatic neuroma in an injured median nerve. Am J Phys Med Rehabil 2009;88(9):771—4.
[25] Tahiri Y, Xu L, Kanevsky J, Luc M. Lipofibromatous hamartoma of the median nerve: a comprehensive review and systematic approach to evaluation, diagnosis, and treatment. J Hand Surg Am 2013;38(10):2055—67.
[26] Marom EM, Helms CA. Fibrolipomatous hamartoma: pathognomonic on MR imaging. Skeletal Radiol 1999;28(5):260—4.
[27] Enjolras O, Mulliken JB. Vascular tumors and vascular malformations (new issues). Adv Dermatol 1997;13:375—423.
[28] Larbi A, Viala P, Omoumi P, Lecouvet F, Malghem J, Cyteval C, et al. Cartilaginous tumours and calcified lesions of the hand: a pictorial review. Diagn Interv Imaging 2013;94(4):395—409.
[29] Kransdorf MJ. Malignant soft-tissue tumors in a large referral population: distribution of diagnoses by age, sex, and location. AJR Am J Roentgenol 1995;164(1):129—34.